

From Horses to Trucks: Implications for Force XXI

A Monograph

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ABSTRACT

FROM HORSES TO TRUCKS: IMPLICATIONS FOR FORCE XXI
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This monograph examines whether or not the U. S. Army's transition from horse drawn field artillery to motorized traction in the interwar years of 1919 to 1941 has relevance to the U.S. Army's movement to an automated command and control system in the twenty first century. The study compares the U.S. Army's field artillery motorization program with its development of automated command and control from four perspectives. First is the ability of the equipment in question to meet requirements for successful use on the battlefield. The second is the impact that various schools of thought had on research, development and implementation of new equipment. Third, the bearing fast paced technological change had on research and development is explored, and finally, the funding, or lack of funding, had regarding the two programs. Based on these criteria, the study concludes that there is a strong relationship between the motorization of field artillery and the implementation of automated command and control.

The monograph illustrates the fact that except for the number of years required to reach various stages, the events surrounding automated command and control are virtually identical to those involved in motorizing the Field Artillery. Both had a small but vocal group of visionaries championing their cause in the early years. Each ran into substantial development obstacles that brought their suitability as a reliable system into question. Likewise, the two programs shared a resistance to their implementation from a small but influential conservative element.

In addition to the strength of the relationship between the two programs, the monograph presents several conclusions, which if applied, will facilitate the transition to automated command and control. First, the Army must recognize and address the requirement to balance the enthusiasm generated by new ideas and emerging technology with the resistance to change inevitable in a large and complex organization. Second, the failure to adequately address resistance to technological innovation leads to undue conservative influence. Third, the Army will continue to lag behind private and commercial applications of computer equipment unless it continues to reform its acquisition program. Finally, the monograph shows that while insufficient funding for research and development leads to obsolete equipment and doctrine, the availability of funds does not guarantee the successful development of new, technologically advanced equipment.

CONTENTS

| | |
|---|---------------|
| INTRODUCTION..... | 1 |
| Background..... | 1 |
| Purpose..... | 2 |
| Research Method and Criteria | 3 |
| Conclusions of the Study..... | 3 |
| CHAPTER 1—THE MOVE FROM HORSES TO TRUCKS..... | 5 |
| The 1920s—High Hope and Bitter Disappointments..... | 5 |
| The Post War Years..... | 5 |
| Experimentation Begins..... | 6 |
| Funding Problems Hurt Development..... | 10 |
| The Impact of Changing Technology..... | 11 |
| 1930-1941—The Shift to Towed Artillery..... | 12 |
| Suitable Vehicles are Developed..... | 12 |
| Funding Arrives But Conservatism Dominates..... | 13 |
| Conclusions..... | 14 |
| CHAPTER 2—THE QUEST FOR AUTOMATED COMMAND AND CONTROL..... | 17 |
| Automated Command and Control Before 1991..... | 17 |
| Automated Command and Control for a New Army..... | 20 |
| Revelations Based on Cold War and Persian Gulf Victories..... | 20 |
| The Advanced Warfighting Experiments..... | 22 |
| The Automation Debate..... | 24 |
| The Technocrats: Arguments for Automated Command and Control..... | 24 |
| The Conservatives: Arguments Against the Automation of Command and Control..... | 25 |
| The Moderate Position..... | 26 |
| Summary..... | 28 |
| CHAPTER 3—ANALYSIS AND CONCLUSIONS..... | 30 |
| History is Relevant in the Move toward Automated C ² | 30 |
| Fast Paced Technological Transformation is Not New..... | 32 |
| Insufficient and Inefficient Acquisition Causes the Army to Fall Behind..... | 33 |
| Proponents of Modernization May Urge Movement Forward Too Early..... | 35 |
| Undue Conservatism is Dangerous..... | 36 |
| Changes in Technology Mean Changes in Training and Doctrine..... | 37 |
| CHAPTER 4—IMPLICATIONS FOR FORCE XXI..... | 39 |
| ENDNOTES..... | 42 |
| BIBLIOGRAPHY..... | 48 |
| ANNEX A-GLOSSARY..... | 51 |

Introduction

Today's Army faces an incredible challenge. In this era of rapid technological change and growing computer capability, how can it integrate the power of the microchip into military operations? Many believe that the pace of change today makes prior history irrelevant, that nothing can compare with the issues the Army faces as it attempts to exploit the latest in information age technology.

This paper argues that just the opposite is true. A similar period of rapid technological change occurred in the interwar years of 1919-1941, and the events which characterized that period have a substantial relevance to the Army's move into the twenty first century. The parallels between motorization in the 1920s and 30s and the Army's automation program are astounding when examined in depth. Given the similarity between the two, the Army can apply lessons from its motorization program to both reduce the adverse effects of modernization and facilitate the transition.

Background

A critical component of the U.S. Army's move to Force XXI is a shift from the manual command and control (C²) systems currently in use to the Automated Battle Command System (ABCS). The argument for this move centers on the theory that automated command and control systems will provide commanders and staffs with a situational awareness more timely and accurate than the opposing force, which in turn allows commanders to react to changes on the battlefield faster than the enemy. The validity of this theory, however, is not universally accepted throughout the Army. Recent articles in professional journals have argued that the move to automated command and control systems will result in information overload and a greater susceptibility to deception, thus increasing rather than decreasing the fog of war. Additionally, the results of recent experiments in digitized command and control indicate that synthesizing the multitude of reports into a relevant common picture poses serious challenges not yet overcome.

The Army experienced a similar period of experimentation and debate as it transitioned from horse drawn to towed artillery in the interwar years of 1919-1941. The

arguments for and against motorization were much like those expressed today regarding automated command and control. As early as 1919, supporters of motorization wrote that the success of experiments justified the immediate transition to motorized artillery as rapidly as possible. Others argued that problems of reliability, cost and mobility associated with motorized artillery were far from solved, and that substantial testing remained before divisional artillery could be motorized. Even as late as 1939, the Chief of Field Artillery argued that the horse still had a place on the modern battlefield.

Purpose

This paper examines the Army's shift from horse-drawn division artillery between 1919 and 1941, and compares it to the development of automated command and control under the Force XXI program. The primary research question is whether the issues and concerns surrounding the conversion from horse drawn to motorized artillery have relevance to the Army's movement toward automated command and control.

Establishing the relationship between these two modernization programs allows the Army to predict and interpret the range of human responses to the contentious issue of Force XXI command and control. Likewise, applying the experience gained during the interwar years facilitates the transition toward the new era of warfare information age technologies will precipitate.

Research Method and Criteria

The conclusions of this study result from a comparative analysis of the Field Artillery's motorization program, conducted between 1919 and 1941, and the U.S. Army's automated command and control program, begun in the early 1960s and continuing through the dawn of the twenty first century. The nature of the two programs was evaluated from four perspectives: 1) the ability of the equipment to meet requirements for successful use on the battlefield, 2) the impact various schools of thought had on

research, development and implementation of new equipment, 3) the bearing fast paced technological change had on research and development, and 4) the effect of funding, or lack of funding, had regarding the two programs.

Conclusions of the Study

This study proves that fast paced technological change is not new to the Army and that history is relevant in the move toward automated command and control. Examination of the interwar years shows that the Army must anticipate and develop effective methods of addressing conservative concerns if it hopes minimize resistance to the implementation of information age technology. Likewise, the movement from horse-drawn to towed artillery indicates that the Army must remain sensitive to the apprehension of individuals as the technology is developed and implemented and it must develop training programs to reduce technological apprehension amongst the force.

The Army must continue the acquisition reform program adopted in the 1990s if it intends to remain on the leading edge of technology. Equally important, the development of doctrine concurrent with equipment is fundamental to maximizing the capability of automated command and control systems once fielded throughout the force. The study also concludes that in an era of shrinking defense budgets and increasing oversight from agencies outside of the Defense Department, the Army cannot afford to push another automated command and control system out to the field before it is unequivocally capable of performing as designed.

Finally, this study illustrates the importance of keeping an open mind when it comes to technological innovation. Today's soldiers must constantly examine how to maximize the capabilities that information age technology might afford.

CHAPTER 1--THE MOVE FROM HORSES TO TRUCKS

The Field Artillery's movement from horse drawn to towed systems over the twenty-two years between World Wars was long, difficult and controversial. A number of challenges had to be met before motor vehicles were able to replace horses as a mover of artillery. Throughout the twenty-year interval between wars, equipment shortcomings, insufficient funding, and undue conservatism were major obstacles toward the establishment of the motor vehicle as a means of transporting the guns.

Nonetheless, throughout the period motorization advocates remained enough of a force to convince a growing number of supporters that the gasoline-powered vehicle would eventually make horse drawn artillery obsolete. As the technology continued to improve over the years, the number of supporters for motorization continued to grow. Unfortunately, a small group of conservatives prevented the full implementation of towed artillery until the entry of the United States into World War II. The result was that on the eve of battle, the Field Artillery was ill prepared to face a modern, well-equipped enemy.

The 1920s: High Hopes, Bitter Disappointments

The Post War Years

Almost immediately after World War I, the U.S. Army began to analyze its performance in combat and what the future might hold. Among the various boards and committees convened by the American Expeditionary Forces (AEF), three in particular, the Hero, Lassiter and Westervelt Boards, had a profound impact on the motorization of division artillery.¹ Collectively, the reports submitted by these three boards formed the basis for a debate lasting over twenty years.² The Hero and the Lassiter Board reports led enthusiastic supporters of motorization to clamor for the immediate shift from horse drawn to motorized division artillery but it was the Westervelt Board which ultimately had the greatest impact on motorization of the Field Artillery.³

The Westervelt Report, issued in May 1919, contained a superb analysis of the lessons learned from World War I as well as a remarkably accurate evaluation of the motorization requirements for the Field Artillery.⁴ The board concluded that the use of animal power as a means of moving artillery pieces had reached its practical limits, stating:

While animal transport, especially with lighter weapons, possess greater mobility, it does not possess a sustained or persistent mobility; exhaustion surely renders it inactive after a limited period and the time required for recuperation is fatal, if coincident with a critical point in the military operation.⁵

Still, the Westervelt Board did not recommend the complete motorization of division artillery, primarily due to the poor reliability and cross-country mobility of the motor vehicles then available.⁶ Instead, the board provided a detailed recommendation for experimentation and development, which in June of 1919 became the War Department's official program for the motorization of artillery. More importantly, the Westervelt program became the foundation for virtually all experiments involving the motorization of artillery between 1919 and 1941.

Experimentation Begins

Given the support of the War Department, the Field Artillery began to experiment with various forms of motorization. Division artillery tests focused on various combinations of 75mm and 105mm self propelled mounts as well as tests to examine both tractor drawn and truck drawn artillery.⁷ The success of some of the earliest experiments prompted a small group of officers, including the members of the Lassiter and Hero Boards, to argue that the time for motorization had already arrived. In a lecture delivered in Treves, France in the spring of 1919, Lieutenant Colonel A.M. Chase reasoned that motor vehicles had a superior control, greater mobility, ease of concealment and lower logistical impact, making them superior to horses.⁸ The same article that quotes Colonel Chase mentions a report by one General Deville, which claimed that artillery on caterpillar mounts was more mobile on uneven ground than horse drawn artillery.⁹

These officers were clearly in the minority, however. While the proponents for motorization were successful in convincing Major General Fred Austin, Chief of Field Artillery, and his successor, Major General Harry Bishop, that motorization had sufficient potential to warrant further experimentation, neither of the chiefs felt comfortable recommending a complete move to motorization. General Bishop in particular believed there were several reasons why motorized transport was not sufficiently developed to support replacing horses. He argued that unlike a motor vehicle, which was dead once it ran out of gas, there was always one more mile that could be coaxed out of a horse, as long as a spark of life remained within it. Additionally, General Bishop thought that horses remained superior to vehicles as far as cross country movement in difficult terrain was concerned.¹⁰

Virtually every experiment conducted in the early to mid 1920s proved that General Bishop's concerns were well founded. One experiment, conducted by the Field Artillery Board in 1923, compared self-propelled artillery to towed and horse drawn methods, primarily in terms of mobility and reliability. The self propelled guns failed almost every test, prompting the board to heavily criticize the arguments made by motor enthusiasts that self-propelled artillery had developed to the point where it could replace the horse as the prime mover of division artillery.¹¹ Instead, the board contended that horses were still superior to motor vehicles when it came to negotiating obstacles, performing long distance movements, and traversing difficult terrain.¹²

Unlike self-propelled artillery, towed systems showed much more promise as a means of moving division artillery. Initial tests concentrated on using commercial tractors to tow the guns, the thought being that their increased mobility and cross-country capabilities made them a more likely prospect than trucks. As the experiments continued, however, the trucks began to surpass tractors as the most likely candidate for motor drawn artillery, largely due to their greater reliability and higher road speeds.¹³ Reliability and cross country mobility continued to be an issue when comparing towed systems to horse drawn methods, but as experimentation continued it became obvious that the concept of motorization had merit, and that future developments would eventually mean the end of horse drawn artillery. Towards the end of the decade, when experiments proved that trucks were the best method of moving the guns, the emphasis shifted to determining what type of truck would be best.¹⁴

The experiments of the late 1920s demonstrated that the concept of replacing horse drawn artillery with a motorized system of one form or another had potential. One of the largest experiments, The Experimental Mechanized Force of 1928, conclusively demonstrated that motorized light artillery had a place on future battlefields.¹⁵ Nevertheless, the notion of complete conversion to motor drawn artillery in divisions was not readily accepted by the majority of artillerymen. Besides the pro motor and the pro horse camps, a group of officers existed that had analyzed the evidence and formed a set of balanced conclusions as to the strengths and weaknesses of both towed and horse drawn artillery. This group formed the predominate view regarding motorization, namely that it was only a matter of time before some form of motorized transport made the horse obsolete on the battlefield, but improvements in automotive technology were necessary before the transition could be made.

In a prize winning essay in 1922, Major William Burr noted that the advent of motorization had revolutionized the concepts of traction, but there was as much that could be said against the tractor as there was in its favor. Burr noted how artillerymen were divided as to the use of motor vehicles as prime movers.¹⁶ He expressed the sentiment of many of his contemporaries when he noted that the days of gas driven vehicles to move the guns were approaching rapidly, but motors were not yet equal to the horse under combat conditions. Besides the limitations of the equipment, Burr was one of the first to understand the radical revision of tactics, training and doctrine that would have to accompany any move from horse drawn to towed artillery, and how difficult such a shift would be. The article also included a warning to overzealous supporters of rapid motorization.

In addition, let us not forget that no matter what the circumstances may be, we must always be prepared and able to fulfill our combat mission, namely, the delivery of our fire when needed. For this reason our experiments must be conducted as such, and our fighting ability remain unimpaired.¹⁷

Many field artillery officers felt caught in the middle of a technical revolution. They realized that motorization might make horse drawn artillery obsolete, but their fears about the reliability of motor vehicles caused them to discourage complete motorization. Influenced by their apprehensions, not technically oriented, and faced with the possibility of restructuring tactics, doctrine and organization, these officers felt that the field artillery should maintain a mixture of both horse drawn and motorized artillery. As late as 1941, many officers retained horses for use in the performance of their duties.¹⁸

Funding Problems Hurt Development

Resistance from traditionally minded officers was not the only obstacle to motorization. Besides conservatism, funding issues in the 1920s had a significant impact on the motorization of light artillery. In 1922, Congress, with War Department support, determined that the large number of war surplus tractors and trucks on hand were sufficient for testing and experimentation. Thus, continued procurement requests for more modern vehicles were continually refused.¹⁹ Even worse, budget constraints imposed by Congress combined with a heavy conservative influence to form a virtually impenetrable obstacle against the development of motorized artillery. As late as November of 1928, the War Department flatly rejected the Field Artillery's proposition for motorizing divisional artillery, stating "The War Department contemplates no departure at present from the principle that division artillery is horse drawn."²⁰

The decision to limit purchases of new equipment and the directive to use aging World War I vehicles placed the field artillery in a difficult position. There was a clear need for newer vehicles specifically designed to handle the unique task of towing light artillery, but the funds simply were not available, even given the promising results of experiments such as those conducted by the Mechanized Force.

Experimentation with motors turned into a series of small scale tests using existing vehicles on long distance convoys. Only occasionally, after scraping up money from other programs, was the Field Artillery able to buy individual, late model vehicles for testing.²¹ The result was that in addition to bureaucratic and technical hurdles, efforts to modernize the artillery had to overcome substantial fiscal obstacles as well. These challenges prompted General Austin to write that lack of funds prohibited his ability to develop motorize light artillery any faster than the pace at which it was proceeding (the official position of the War Department against motorizing division artillery notwithstanding).²²

The Impact of Changing Technology

Another challenge to motorization had to do with the rate at which automobile technology was advancing. American auto manufacturers continued to invest heavily in research and development, the result being increases in reliability, mobility and carrying capacity with simultaneous decreases in maintenance and operating costs. For example, between 1920 and 1930, hydraulic brakes, pneumatic tires, high torque engines, four and six wheel drive transaxles and constant velocity joints had all been either invented or perfected, and became available on commercial vehicles.²³

The lack of funds and refusal of the War Department to support the purchase of newer vehicles forced the Field Artillery to conduct their experiments using old, worn out and obsolete equipment vastly inferior to the types of vehicles available by the late 1920s. Not surprisingly, those opposed to motorization took full advantage of the failures of World War I era vehicles to meet the requirements in an attempt to discredit motorization in general, while supporters complained that tests using antiquated equipment could hardly be considered conclusive.

1930 to 1941: The Shift to Towed Artillery

Suitable Vehicles are Developed

Fortunately for the Field Artillery, General Bishop, who became Chief of Field Artillery in 1930, decided that motorization was sufficiently important to continue experimentation and development regardless of the

War Department directive that division artillery was to remain horse drawn. Using whatever funds he could scrape together, and continually complaining to Washington that additional funds were desperately needed, Bishop was determined to take advantage of the progress made in motor vehicle design and capabilities.²⁴

At the same time, the quality of motor vehicles had finally reached a point where they were undoubtedly superior to horses. The 1-½ ton Ford truck became a particular favorite of both the Quartermaster Corps and the Field Artillery. This truck was equipped with a Warford transmission, which provided a range of twelve forward and three reverse speeds, as well as Hipkins tracks, which consisted of a series of plates that could be placed over the wheels in soft terrain to provide additional traction.²⁵ General Bishop felt that the Ford trucks, as well as others in production, had finally solved the problems of reliability and off road mobility that were keeping the Field Artillery from becoming completely motorized.²⁶

Despite General Bishop's support for motorization, conservatism among a number of Army officers continued to have an overwhelming influence on the War Department, which in turn led to a cautious approach toward the development and fielding of towed, light artillery. The conservative minority proved to have a greater influence on the War Department than the growing supporters of motorization, inducing the War Department to withhold modernization funds until 1933, effectively stalling the conversion to motorized prime movers, even after suitable vehicles had finally been identified.

Funding Arrives but Conservatism Dominates

Fortunately, the year 1933 proved to be an important one for the Field Artillery. Over the years since the First World War, the population of suitable horses declined steadily from 21.5 million in 1919 to less than 14 million in 1932. The resulting decrease in trained mounts meant that by 1932 old age and injuries were decremending the Army's horse population faster than it could be replaced.²⁷ Realizing that the availability of horses was decreasing, and the reliability of motor vehicles was increasing, Army Chief of Staff Douglas MacArthur initiated a broad modernization program. In 1933, based on MacArthur's program, the War

Department finally authorized the motorization of fifty percent of the light artillery in the Army. Under the motorization program, the Field Artillery was able to motorize fifty-six of the Army's eighty-one 75mm batteries by the end of 1940.²⁸

Even with approval from the War Department for a partial conversion of light artillery, the declining population of horses, and the repeated success of motorization experiments, a powerful group of conservative artillerymen was successful in preventing full motorization. No one typifies the conservative position better than Major General Robert Danford, Chief of Field Artillery from 1938 to 1942. In a lecture at the Army War College in September of 1939, General Danford told students that the horse still remained superior as the prime mover off roads, through the mud, in the dark and in rain."²⁹ Danford repeated his arguments in a 1939 *Cavalry Journal* article, in which he stated that although the horse resources in the United States were diminishing, it would be foolish to disregard the still substantial population of suitable mounts.³⁰ Besides his arguments on mobility, General Danford felt that the demand for steel in time of war would become "insatiable" and using horses rather than trucks for a portion of the division artillery would help offset the increase in demand.³¹ Rather than a policy of "horse or motor" Danford insisted on one of "horse and motor". In a policy memorandum issued in November 1938, General Danford insisted that the twenty-two remaining batteries of horse drawn artillery remain so indefinitely.³² Under Danford's express direction, courses on the training and handling of horses remained in the Field Artillery School curriculum through the end of 1941.³³

Conclusions

Following World War I, both the Field Artillery and the Army as a whole recognized that the application of motor technology to future battlefields required examination. The establishment of the Westervelt and other boards played a major role in determining whether or not the concept of motor drawn artillery had enough potential to warrant further experimentation, and what the experimentation program should entail. The impact of the Westervelt Board's scientific and impartial analysis on the development on motorized artillery was profound. More importantly, the board concluded that although the potential for motor vehicles to replace horses on the battlefield was very strong, the reliability of existing trucks and tractors had not yet reached the level where they could replace horses in division artillery. Later experiments proved the Westervelt board to be highly accurate in its assessment.

Despite evidence to the contrary, a small group of officers such as Lieutenant Colonel Chase and General Deville and the members of the Lassiter Board believed that the technology had been proven sufficient, and the time for full motorization had come as early as 1922. This band of progressive officers had a vision that accurately predicted the impact of motorization on the Field Artillery. The problem was not the vision; it was the equipment available at the time. One can only speculate on how a full fielding of vehicles before the technology was sufficiently developed might have affected the Army, but one fact remains clear. Automotive technology in the early to mid 1920s simply had not progressed to the point where it was superior to the mode of transport already in use for transporting light artillery. Those who advocated full motorization in the 1920s were premature, either ignoring the results of early experiments or overly assessing the reliability of the vehicles available at the time.

Conservatism, both directly and indirectly, formed the greatest obstacle to the motorization of light artillery. A small but influential group of old school officers remained unconvinced of the emerging superiority of motor vehicles, and they were troubled by the drastic changes in doctrine, tactics and techniques that the technology of motorization would force upon them. As a result, the traditionalists over emphasized both the limitations of motor vehicles and the strengths of horse drawn traction throughout the interwar period.

The combination of conservative influence and large numbers of World War I vehicles in the inventory led the War Department to stifle the development of towed artillery, even after suitable vehicles became available in the early 1930s. To make matters worse, the declining number of suitable horses made any alternative short of full motorization less feasible as the years passed. Only after analyzing the performance of artillery in the Spanish Civil War and early stages of the Second World War did the Army realize it had made serious miscalculations regarding the effectiveness of motorized artillery as part of a combined arms team. In particular, observers in the United States realized that on a mechanized, combined arms battlefield, the best way to integrate artillery fires with high-speed maneuver was through towed division artillery.³⁴

Three distinct schools of thought emerged during the years of 1919-1941. The first consisted of those who believed the time for motorization was at hand. In the early 1920s, this faction was nothing more than a tiny minority of motor enthusiasts. Gradually, as the technology continued to improve, the number of artillerymen advocating the move to towed artillery grew. By the eve of World War II, the majority of artillerymen were supporters for the motorization of division artillery.

The second group was comprised of officers who felt that motor vehicles would eventually replace horses, but the time had not yet arrived. As the technology improved over the interwar period, the majority of the second group moved over to join the ranks of motorization advocates. The third group contained the holdouts against motorization. They believed that the horse would have a place on the battlefield indefinitely, and as such were adamantly opposed to a complete motorization of division light artillery. While small and continually diminishing in numbers, the conservative group had an influence over the War Department disproportionate to its size, and unfortunately, it affected the motorization program from start to finish. Hence, the early optimism generated by the first generation of motorization experiments turned into feelings of disappointment and frustration caused by inadequate equipment and obstinate leaders.

CHAPTER 2-- THE QUEST FOR AUTOMATED COMMAND AND CONTROL

According to Martin Van Creveld, command in war consists of an endless quest for certainty about the state and intentions of the enemy, the environment in which the war is fought, the weather and terrain, and the state of one's own forces.³⁵ As the technology of computers advances at an exponential rate, the ability to gather real-time, all-weather information combines with an increasing ability to process and interpret volumes of data, giving commanders a situational awareness previously unattainable using manual methods. If a friendly commander's situational awareness is greater than that of his enemy, he has what Admiral William Owens refers to as dominant battlespace knowledge (DBK).³⁶ In theory, the commander can use this DBK to make better and more rapid decisions than his opponent, which in turn gives him a marked advantage on the battlefield. The notion of DBK is at the heart of the Army's rationale for automating command and control.

Automated Command and Control Before 1991

The concept of using computers to facilitate command and control is not as new to the Army as one might infer from contemporary literature. As early as 1969, General William Westmoreland envisioned an Army built into and around an integrated battlefield control system that exploited the advanced technology of communications, sensors, fire direction and automatic data processing.³⁷ From the early 1960s through the Persian Gulf War, a number of automated systems were conceived, tested and in some cases fielded. Each successive generation of C² systems was supposed to take advantage of recent technological improvements as well as lessons learned from previous generations. Between 1960 and 1991, the Army developed five different generations of automated command and control systems, albeit to varying degrees of production and fielding.³⁸

The Army's first attempt at automating the C² process was a project called "FIELDATA" and lasted from 1960 until its funding was eliminated in 1962.³⁹ In 1964, based largely on insights gained from FIELDATA, a program called "Automatic Data Systems within the Army in the Field" (ADSAF) became the second generation of command and control systems. ADSAF research led to the development of three

subsystems: the "Tactical Fire Direction System" (TACFIRE) for the tactical and technical control of artillery, the "Tactical Operations System" (TOS) for maneuver and intelligence data processing, and the "Combat Service Support System" (CS³) for the automation of logistics functions. Research and development on these three subsystems continued when the Army transitioned to its third generation system, the "Army Tactical Data System" (ARTADS) in 1971.⁴⁰

TACFIRE, TOS and CS³ used different hardware and software and were only partially compatible with one another. ARTADS project managers tried desperately to gain control of this highly fragmented computerization program, but hardware and software problems plagued the project throughout its existence, eventually forcing its cancellation.⁴¹ Of the three subsystems, only TACFIRE continued in its development as an autonomous, rather than integrated fire control system.

"Sigma Star" was the Army's fourth generation system.⁴² Its backbone was the Maneuver Control System (MCS), intended to form the core of a multi-component structure that would process information to and from intelligence, fire support, air defense and logistics subsystems. Ironically, Sigma Star/MCS started as an integrated C² system that would provide the digital transmission of battlefield information across functional areas, but organizational politics and an inefficient acquisition program led to the development of subsystems that were incapable of achieving that objective.⁴³

In the late 1980s, Sigma Star was renamed the "Army Tactical Command and Control System" (ATCCS), with MCS remaining the horizontal integrator of information across the battlefield. Conceptually identically to Sigma Star, the main difference in ATCCS was that it used common hardware and software platforms in an attempt to hasten the integration of the five battlefield functional areas. Despite a concerted attempt to make the systems work, performance of ATCCS remained substandard. Following tests in 1990, the Army determined that MCS failed to provide timely and accurate information across the battlefield environment.⁴⁴ Even worse, a Government Accounting Office report highly criticized MCS, claiming it was nothing more than a very expensive way of passing facsimile messages.⁴⁵

Consequently, the Army tried in vain over a thirty-year interval to implement an automated command and control system. Not surprisingly, one of the primary reasons for the failure of automated C² was the fact that suitable equipment and software had yet been developed, as evidenced by repeated failures during tests. Another reason, according to Elizabeth Stanley, was that advances in technology outpaced the slow

and inefficient acquisition style the Army was using.⁴⁶ After spending millions of dollars, the Army had little success in spite of an effort lasting longer than the careers of most its officers.

Automated Command and Control for a New Army

Revelations Based on Cold War and Persian Gulf Victories

Following the Persian Gulf War the Army realized that it needed to move information around the battlefield more efficiently than in the past, and it was increasingly clear that ATCCS in its current form could not fulfill that requirement. The Cold War was over, and with it the likelihood that the Army would fight a high intensity conventional war in Europe. Senior leaders understood that the Army needed to shift from a forward deployed force to one of force projection, and along with this change of focus came a new approach toward automated command and control. "Stove piped"⁴⁷ information flow within different functional areas no longer facilitated fighting opponents simultaneously throughout the depths of the battlefield.⁴⁸

Given the change of threat, the failure of C² systems already in development to perform to design standards, and the promise shown by emerging technologies, Army Chief of Staff General Gordon Sullivan initiated the Force XXI program in the spring of 1992. At the heart of the program were two fundamental concepts: the horizontal and vertical integration of C² systems already existing or in development, and the extension of automated data processing to the lowest echelons of the battlefield through the use of a tactical internet.⁴⁹ In September 1993, ATCCS was renamed the Army Battle Command System (ABCS) in an attempt to reflect the Army's new model regarding digitization.⁵⁰ The result of General Sullivan's Force XXI initiative was an ambitious ABCS development and testing schedule, particularly for MCS.

MCS remained the core subsystem of ABCS, but as with early versions, the system continually failed to meet development timelines and performance specifications. In August 1992, the General Accounting Office (GAO) issued a report which strongly criticized the Army's program for development of ABCS, especially the Army's decision to commit \$1.8 billion toward the purchase of equipment prior to testing to ensure all five of the subsystems would work together as intended.⁵¹ Although the Army made some minor modifications to the ABCS schedule based on the GAO report, the program essentially proceeded in spite of these reservations.⁵²

Despite more than adequate funding, support from the highest echelons of the Army, and rapidly developing technology, MCS continued to suffer from software problems. The Army canceled the development of Version 11 software in February 1993 because of serious design flaws and cost overruns. The initial test and evaluation of Version 12.01 software slipped two and one-half years due to continuing software troubles. Nevertheless, the Army was determined to continue with the development of new software, awarding contracts for Versions 12.2 and 12.3 before the operational testing of each version's predecessor. This prompted another, even more damaging GAO report in October 1997, which claimed that the Army had spent \$765 million on MCS since 1993, and was planning to purchase an additional 207 systems, in spite of no successful operational test or approval for production.⁵³ Unlike the first GAO report, the Defense Department was forced to concur with the majority of GAO's findings, and it directed the Army not to procure or field additional MCS hardware for operational units until the system had successfully completed an Initial Operational Test and Evaluation and received a procurement approval decision.⁵⁴

The Advanced Warfighting Experiments

A central concept within the Army's Force XXI program was the use of a series of Advanced Warfighting Experiments (AWEs) to periodically validate the progress of both systems and doctrine.⁵⁵ Two 1994 events, Desert Hammer and Desert Capture III, formed the baseline for the two AWEs conducted in 1995 - Focused Dispatch and Warrior Focus. These in turn formed a rolling baseline for the spring 1997 Brigade Task Force XXI AWE (TF XXI AWE).

The major goals of the TF XXI AWE were to document improvements in survivability, lethality, and operational tempo, but the Army also hoped the exercise would provide insights to division and corps command and control processes. The insights gained during the TF XXI AWE formed the foundation for a division level Battle Command Training Program (BCTP) exercise, called the Division XXI Advanced Warfighting Experiment (DAWE). Conducted in November 1997, the DAWE used an established computer simulation in conjunction with prototype ABCS systems, including an updated version of MCS, to test automated C² in a live, interactive environment.⁵⁶

Initial reviews of the task force and division AWEs were mixed. According to an Operational Test and Evaluation Office (OT&E) observation team, "there was no increase in lethality, survivability or

operational tempo attributable to digitization". OT&E also suggested that the number of fratricide incidents during the experiment were higher than those on a typical National Training Center (NTC) exercise: there were 32 cases of fratricide during the AWE compared to a combined total of 28 for the three previous conventional NTC exercises. This was in direct contrast to predictions made by digitization advocates that real time situational awareness would decrease fratricide on the battlefield. Moreover, electronic warfare officers in the Opposing Force said they could detect and locate the experimental force's tactical operations centers twice as fast as they could those of conventional brigades training at NTC.⁵⁷ The commanding general of the Army's Training and Doctrine Command, General William Hartzog, dismissed these findings, claiming that the experimental force's performance was "at least as good, and in some cases much, much better" than the three task force exercises preceding the AWE. General Hartzog believed the fratricide increase was due to the extended length of the TF AWE and additional soldiers that took part in it: six days longer and 1,800 more soldiers than the standard brigade level exercise. In terms of electronic vulnerability, Hartzog countered that the experimental force performed better than anticipated, and that funding was sufficient to fix identified deficiencies within 2 years.⁵⁸

The majority of AWE reviews, however, were highly positive. Most of the reports and articles concluded that at a minimum, the concept of automated C² had merit. They made particular note of a vastly improved, though as yet imperfect, ability to see themselves, their environment and their enemy. It was obvious that the equipment used in the experiments was not sufficiently developed to recommend an immediate shift to electronic command and control, but given the rapidly improving capabilities of computers to communicate and process data, it was clear to a good number of officers that the future of the Army lay with some sort of digitized command and control system.

The Automation Debate

The diversity of debate generated as a result of the AWEs was profound. Vast amounts of sometimes conflicting data collected during the experiments allowed observers to support virtually any argument they intended to make: that automated C² was the wave of the future, that it was foolish to depend on computers to reduce the fog of war, or a moderate position laying somewhere in between these two poles.

The Technocrats: Arguments for Automated Command and Control

Almost immediately following the implementation of the Force XXI program and its associated experiments, articles advocating the rapid implementation of automated C² began to appear in military professional journals. Many articles made predictions about how advanced information technologies would lead to dominant battlespace knowledge. Advocates of this school asserted that the emerging technology and resulting "information dominance" would vastly reduce, if not eliminate friction and the fog of war, providing the commander and his subordinates with nearly perfect situational awareness, subsequently reducing the risks associated with the use of military force.⁵⁹ In "The Future of Command and Control with DBK", David Alberts claimed that the Army would move from situations in which decision making took place under uncertainty or in the presence of incomplete and erroneous information to situations where decisions were made with nearly perfect information.⁶⁰ In short, the technocrats argued that technology would enable commanders to see and understand the entire battlefield, and as a result, win the war.⁶¹ Others argued that automating C² functions would help free commanders to deal with only those decisions that the systems was unable to handle. Automated C² systems would allow commanders to make multiple decisions simultaneously rather than sequentially, thus establishing a faster operational tempo than an enemy using manual methods. By inputting mission priorities, rules of coordination and engagement, degree of difficulty ratings, etc., commanders could set a "required confidence level" that had to be achieved before ordering the execution of a particular mission.⁶² An additional benefit to improved situational awareness would be the reduction of fratricide among friendly forces spread throughout the battlefield.⁶³

The Conservatives: Arguments Against the Automation of Command and Control

As the proponents for automated command and control began to present their opinions to the military establishment, those opposed to the idea presented a series of counter arguments. The predominate argument against automated C² systems concerned technocratic claims that automated C² systems would reduce uncertainty and the fog of war to a point where they became irrelevant to the commander. Citing Clausewitz's *On War*, Mackubin Owens countered by emphasizing that war dealt with living, moral forces and therefore would always have a degree of uncertainty. Rather than reduce uncertainty on the battlefield, Owens believed that information technology systems would move fog and friction to a higher plain.⁶⁴

Others countered with the belief that the possession of an information advantage in and of itself would never be sufficient to win wars. The possession of data or information could only be put to use by the process of cognition, achieved through analysis, evaluation and integrations. While it was possible for technology to assist in the process, cognition was primarily a function of the human intellect. True situational awareness only results when the commander, based on the synthesis and application of knowledge, achieved an understanding of the situation around him. Napoleon's *coup d'oeil* reflected true situational awareness, not the flood of raw data into a computer.⁶⁵ Related to this argument was the notion that computer based command and control systems would amass more data than commanders and staff were able to assimilate, making it difficult to sort out the critical information from the routine.⁶⁶

Other, less significant reasons for avoiding automated C² also surfaced. One was that no matter how technologically sophisticated the U.S. military may become, small opponents would fight back by channeling their aggression in ways which circumvented, undermined or neutralized the technology Americans brought into the conflict. They also believed that the reliance on information technologies carried inherent weaknesses that opponents could discover and exploit. Third, conservatives thought that the systems approach to military operations only applied to conflicts similar to Desert Storm, where the open terrain and an incompetent opponent gave the U.S. enough time to mass an overwhelming force. Fourth, the vision of near real time situational awareness refuted the wisdom of experience and history regarding the fog and friction of war in that given the chaotic and ambiguous nature of war, the only thing certain about combat was that commanders never have all of the information they require. Finally, the conservative view point claimed that in an age of severely restricted budgets, no peer threats to U.S. security and a C² system capable of meeting the current requirements, the funds required to implement automated C² were better used elsewhere.⁶⁷

The Moderate Position

As the twentieth century came to a close, the most prevalent position regarding the automated C² debate was one which recognized that the movement toward some sort of automated command and control system was inevitable given the rapid developments in technology and the ever increasing complexity of military operations. While supporting the rapid movement to an automated system, these moderate observers

recognized that several challenges had to be met before the Army was ready to implement the change across the entire force.⁶⁸

Not surprisingly, the predominate argument was that the technology, although rapidly improving, had not yet reached the stage where it met all of the necessary requirements. This position was borne out in both exercise reports and articles in professional journals. For example, all five of the digitized command and control experiments examined for this study concluded that the potential for automated C² was high, but that none of the systems tested performed sufficiently well to support the conclusion that the right hardware and software was in place for a full implementation to begin.⁶⁹ The reports cited insufficient horizontal integration of subsystems, inadequate communications infrastructure, cumbersome equipment, and unsuitable data synthesis and presentation as the primary reasons why ABCS was not ready for full-scale production. Describing his experiences during the TF AWE, Colonel Rick Lynch said:

ABCS technology is still far from perfect. I told the Chief of Staff of the Army this. The problem is still that we do not have an integrated system. MCS is not an integrator. It is supposed to be, but it is not even close. Everyone asks, "what does the commander need?" All the commander needs is an integrated Red/Blue picture, on some screen, which also has the things that effect his operation in his battlespace. Where are the natural obstacles? Where are the man made obstacles? Where is the persistent chem.? Where did the FASCAM go? If all the tactical maneuver leaders are looking at that same picture, at the same time, then it's a homerun. That's what you have to get to.⁷⁰

Another frequently articulated position was that automated C² systems would undoubtedly reduce uncertainty on the battlefield, but would most likely fall short of achieving near perfect situational awareness. No matter what system was in place, intuitive skills would always be called upon to bridge the gap between the information provided by C² systems and the information required by a commander to make decisions.⁷¹ War would continue to require boldness, as well as the willingness to accept risk and responsibility. Plans would remain based on assumptions requiring sound judgment.⁷²

Besides these two predominant arguments, nearly all of those cautiously optimistic about automated C² recognized that a substantial retraining effort would be required. Operators would need training in order to maximize the utility of the machines themselves. More importantly, leaders would need to be taught how to use the information provided, when to trust it and when to question it, and how to use DBK to defeat the opposing force.⁷³ They also recognized that an accurate assessment of the situation around them did not necessarily guarantee that commanders would make the best decisions. History is full of examples of

commanders making poor decisions even though they had sufficient, timely and accurate information. How the information was used, not how much was available, was at the heart of winning wars.⁷⁴

Summary

As the twentieth century ended, nearly forty years had passed since the Army's first attempts to use computers as a medium for command and control. A rash of failures, over expenditures and organizational inefficiency marked the first thirty of those years. The 1990s, on the other hand, saw increases in computing capability and a change of environment that caused the Army's senior leaders to reevaluate automated C². The Advanced Warfighting Experiments validated the notion that a network of computers passing information across the battlefield, could in fact improve a commander's situational awareness. Based on the AWEs, some saw the development of suitable computer systems by the year 2000.⁷⁵ The majority of officers were not quite as optimistic, but they recognized the potential of automated C² and realized that it was only a matter of time before the technology could support making the move from a manual to an automated system.

Despite experiment results showing how a computerized C² system could help commanders and their staffs, a small group of conservatives questioned the movement toward those systems. They saw in the implementation of automated command and control a shift in, rather than the elimination of, fog and uncertainty in war. Rather than embrace the concept of dominant battlespace knowledge, the conservatives saw the concept as outright dangerous. Given the impact conservatism had on the motorization of field artillery and the fact that a suitable automated command and control system has yet to be developed, it is logical to conclude that the potential for conservatives to influence the adoption of automated C² remains high.

CHAPTER 3--analysis and conclusions

History is Relevant in the Move toward Automated C²

Clearly, a relationship exists between the Army's movement from horse-drawn to motorized field artillery and the movement from manual to automated command and control. As depicted in Figure 1, both programs grew out of efforts by early visionaries to adapt a promising technology to the military environment. For motorization as well as automation, initial attempts to move from concept to reality were unsuccessful, primarily due to the immaturity of the technology. Yet, the proponents of each of the new technologies were successful in their efforts to continue research and development in spite of repeated failures and equipment shortcomings.

In both cases, the technology eventually progressed to a point where the Army became comfortable fielding an experimental force with the latest versions of equipment available. Each of the test units had a requirement to evaluate whether or not the latest in a series of technological improvements meant that the equipment in question could meet the needs of the Army, either then or at some point in the future. The result of both experimental force evaluations was a validation of the concepts that they were directed to observe; motorization of light field artillery in 1928 and the digitization of command and control in 1997.

Following publication of the experimental force results, the level of debate concerning the strengths and weakness of the theories involved began to grow in intensity. Most of the arguments centered around the potential for the new equipment on modern battlefields. In both cases, there was an increase in the level of effort of conservatives and technocrats alike to steer the Army's decision makers toward their respective points of view. Arguably, those arguing against motorization were more vocal and effective in getting key decision makers to adopt their recommendations than those against automated C². Nonetheless,

examination of the interwar years makes it clear that the potential for adverse conservative impact on automated C² is still strong.

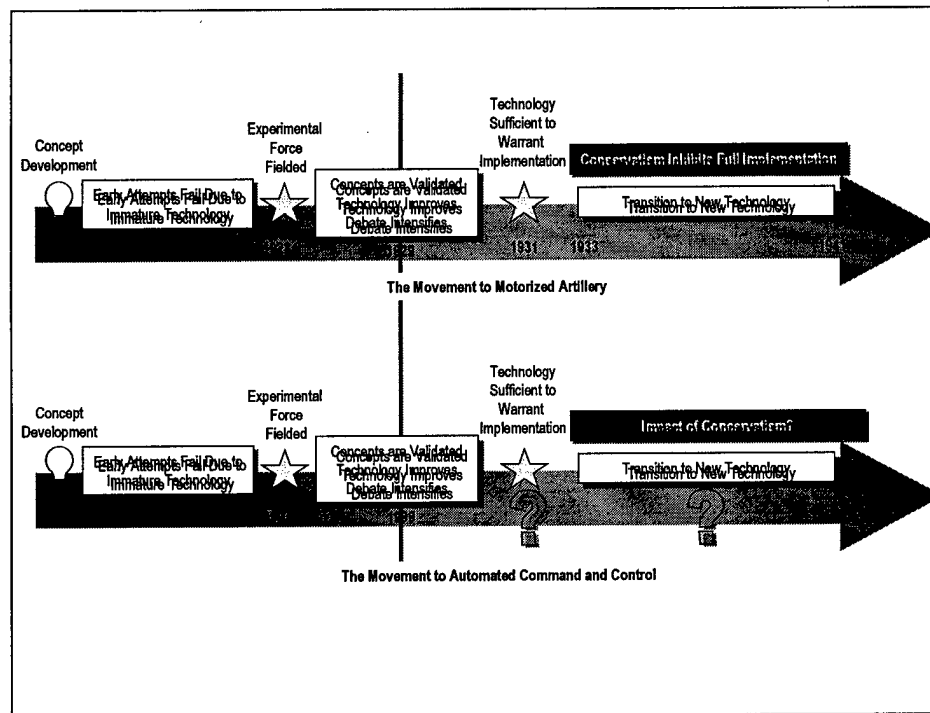


Figure 1: Motorization and Automation Timeline

The vertical line in Figure 1 represents a subjective assessment of where the Army is in 1999 regarding the movement toward automated command and control relative to the timing of events surrounding the motorization of divisional field artillery. As far as automated C² is concerned, the Army is at about the same point in 1999 as it was concerning motorization in 1929. The hardware and software required to make the transition to digital command and control are not yet sufficient, but given the rapid increase in computer capabilities over the last few years, the development of a suitable automated C² system is likely to occur within five to ten years. Following the maturity of that capability, the Army can expect an attempt from conservative officers to slow, if not prevent, the movement to an automated C² system. Consequently, the Army must anticipate and develop effective methods of addressing conservative concerns if it hopes to reduce the impact of officers like General Danford, who insisted on keeping a quarter of the Army's division artillery horse drawn long after motorization was the obvious path to the future.⁷⁶

Fast Paced Technological Transformation is Not New

After analyzing the movement to motorized field artillery, the notion that Army of the late 1990s exists in an environment of unprecedented technological change becomes less convincing. While there is no doubt that the rate of improvement in computer technology in the 1990s is far greater than that of automotive technology in the 1920s and 30s, it appears that rapid technological change was just as challenging to soldiers of the interwar years as it is to America's post Cold War Army in the 1990s. Just as soldiers of the post Cold War Army must transition from a Soviet centric, European combat mentality to one of operations ranging from peace keeping to multi-theater war, soldiers of the interwar years had to adjust their thinking to account for the movement from the stagnant trenches of France to motorized, maneuver warfare.

In both of the periods examined, emerging technology forced the Army to consider replacing a traditional and reliable means of applying combat power with one of unproven validity. Many officers in the 1930s had fears regarding the reliability of the new equipment, largely due to their lack of technical expertise. These fears combined with an apprehension toward the necessary restructuring of tactics, doctrine and organization required as part of the movement to towed artillery. The result was a transition from older method to newer that was long and difficult.

The Army's current method of developing of tactics, techniques and procedures concurrent with the development of C² hardware and software is a major step toward reducing the impact those inhibitions might have. Nonetheless, examining the motorization program shows that personal reservations can have a significant impact on the large scale implementation of new technology. The movement from horse-drawn to towed artillery indicates that the Army must remain sensitive to the apprehension of individual soldiers as technologically advanced equipment is developed and implemented. Training programs designed to reduce technological apprehension may facilitate the introduction of new equipment and doctrine amongst the force as a whole.

Insufficient and Inefficient Acquisition Causes the Army to Fall Behind

Though due to different reasons, the Army's inability to keep up with changes in technology is equally evident in motorization as well as automation. During the interwar years, the failure was caused by the War Department's 1928 directive prohibiting the development of motorized division artillery combined with its refusal to fund the purchase of newly designed vehicles. In the move to automation, an inefficient

research and development system caused the gap. Both problems had the same effect. The application of newly available technology within the Army fell behind that in the commercial sector. In the late 1930s, the Army belatedly realized that its failure to acquire a suitable towed artillery system for its divisions had potentially catastrophic consequences. Despite efforts to make up for lost opportunities, when war broke out in December 1941, only seventy per cent of the division artillery was motorized.

Today shipping and trucking companies throughout the world have an equivalent of situational awareness that the Army has yet to achieve. Using the Global Position System, cellular communications technology and computerized databases, shippers can instantly determine where a specific truck or package is, where it has been and when it will reach its destination. Using this information, they can change, reorient and reallocate assets in response to changes in the environment, whether it is the pick up of an unscheduled package or the breakdown of one of their trucks. One can argue that the introduction of a thinking opponent directly attacking a commander's information age C² systems makes the military achievement of situational awareness far more challenging and complex. The fact remains that the civilian sector has developed and implemented a concept the Army has yet to realize in spite of all its efforts. Therefore, the Army must continue its acquisition reform program if it intends to remain on the leading edge of technology.

As part of its acquisition reform program, the Army needs to find a medium between the two funding extremes apparent in the two programs examined. Chapter 1 discussed how the failure of the Army to adequately fund the Field Artillery's motorization research and development was one of the many reasons why the Field Artillery was unprepared for World War II. Perhaps the Army recognized the impact of previous funding shortfalls and attempted to avoid a repeat of the problem as it developed its automated command and control systems. Still, adequate funding does not necessarily guarantee the successful development of a system, as evidenced by the repeated failures of MCS in spite of the millions of dollars spent on its development.

Proponents of Modernization May Urge Movement Forward Too Early

Progressive thinkers such as Colonel Chase, General Deville and the members of the Lassiter Board had a vision that accurately predicted the impact of motor vehicles on the field artillery. Based on that vision, they urged a rapid transition from horse-drawn to motorized artillery as early as 1922. Such

recommendations were premature. The cross-country capability and reliability of motor vehicles did not progress to a point where they were superior to horses until about 1931. An influx of funds from the War Department in the 1920s may have sped development somewhat, but the fact remains that automotive technology was too immature to support shifting from horse-drawn to towed artillery at the time early enthusiasts recommended.

Rather than recommend an immediate shift from horses to tractors, as the Lassiter Board proposed, Major General William Snow, Chief of Field Artillery at the time, wisely chose a different approach. General Snow used the results derived from early experimentation as evidence that the concept of motorization was sound, but did not recommend an immediate shift to towed artillery. Instead, he argued that further research should focus on developing a vehicle that had the mobility and reliability required before the Field Artillery replaced its horses. Subsequent Chiefs of Field Artillery did not recommend the full implementation of towed division artillery until 1931, when it was undeniable that the trucks were superior to horses for moving guns across the battlefield.

Unfortunately, the Army failed to adopt a similar approach in its quest for an automated command and control system. Massive investments in immature technology led to the premature fielding of the Maneuver Control System, which in turn led to the expenditure of millions of dollars on a system incapable of performing to design standards. The fielding of MCS before it was able to meet design requirements prompted substantial criticism from within as well as outside of the Defense Department and it contributed to the distrust of automation equipment already existent within the Army.

Undue Conservatism is Dangerous

Examination of the interwar years proves that undue conservatism can result in a loss of superiority in terms of weapons technology and tactics. When the Army and War Department began to digest lessons from the Spanish Civil War and early battles of World War II, senior leaders realized that they underestimated the impact that motorized artillery had when combined with tanks and infantry on the modern battlefield. Equally obvious was the fact that the failure to support the research and development of towed division artillery in the mid to late 1920s was a poor decision. The result, according to Boyd Dastrup, was that in spite of the efforts of a group of progressive officers to move the artillery forward, on the eve of World War II the Field Artillery was characterized by obsolete weapons and thinking. This left

the branch poorly prepared technologically and tactically to fight armies that were adopting the latest in weapons and tactics.⁷⁷

As in the interwar years, many army officers today are apprehensive when it comes to change, especially when it is both rapid and drastic. Perhaps this reluctance occurs because the more experience a soldier gains, through training, assignments, etc., the more he is inclined to want the future to remain within the context of that experience. Unfortunately, the dynamic nature of the world makes such desires dangerous. While the reluctance to support change may be natural, examining the interwar motorization of artillery shows that it can be counterproductive. In much the same way that Army officers of the 1930s had to accept the automobile as part of American society, today's army officers must recognize that computers are here to stay. Like horses in the 1930s, the Persian Gulf War demonstrated that manual command and control methods might already be obsolete. Soldiers must keep an open mind when it comes to technological innovation, constantly examining how to maximize the capabilities that information age technology might afford.

Changes in Technology Mean Changes in Training and Doctrine

Central to both motorization and automation was the idea of increasing the tempo of battle to a point where events occurred faster than the enemy could react to them. In the 1930s, the increase was sought via high speed maneuver. In the 1990s, the use of dominant battlespace knowledge is the method. Motorization implied forgoing slow, methodical, set piece battles of World War I in lieu of a return to movement throughout the battlefield and therefore a departure from the established doctrine. Yet many officers either failed to recognize the requirement for change, or they were unable to accept it.

Likewise, the achievement of dominant battlespace knowledge demands a doctrine that provides the flexibility to adjust to the rapidly changing situations that must occur if DBK is to be of any use. In the same way that motorization required a reassessment of doctrine, tactics and training programs was necessary, the shift to automated C² requires a reevaluation of current battlefield practices and is essential to maximizing the capability of future automated command and control systems.

The implications surrounding such a change in doctrine are just as profound in the 1990s as they were in the 1930s. The changes mean moving from well established concepts and procedures to less familiar methods, potentially more complex and more difficult to understand. The previous section mentioned the apprehension a change in doctrine can bring. Nonetheless, the Army must continue its efforts to develop doctrine concurrent with the movement of automated C² systems if it wishes to avoid the tactical obsolescence that occurred as the United States entered World War II.

CHAPTER 4--IMPLICATIONS FOR FORCE XXI

Examining the Army's transition from horse-drawn to motorized artillery demonstrates that the requirement to deal with rapid technological change is not new. Undoubtedly, the issues and concerns surrounding the conversion from horse drawn to motorized artillery have relevance to the Army's movement toward automated command and control as well as other aspects of Force XXI. In some cases, such as the development of doctrine concurrent with equipment, the Army attempted to apply insights gained during the motorization process toward automation. In other cases, the Army was less successful, as in the failure to ensure equipment could perform to design standards before fielding it.

The most significant, as well as the most challenging implication for the Army as it moves toward automated command and control is the requirement to balance the enthusiasm generated by new ideas and emerging technology with the resistance to change inevitable in a large and complex organization. Overly optimistic visionaries have a tendency to recommend the adoption of new technology before it is sufficient to meet the Army's needs. The Army must offset the resistance to change so prevalent in large organizations with the recognition that change is inevitable in a dynamic world. The Army must temper the enthusiasm generated by fresh ideas and successful experiments with a constant measure of reality, while simultaneously exploring how it can maximize the capabilities that information age technology afford. An open, yet rational and realistic mind may be the most significant asset today's soldier can have. In the movement to towed artillery, the failure to adequately address resistance to technological innovation led to undue conservative influence. Examining the U.S. Army during the interwar years demonstrates the requirement to anticipate and effectively address conservative concerns in order to minimize resistance to the implementation of information age technology. Although conservatism has had less of an effect on automation than on motorization, it is important to remember that long after equipment suitable for the motorization of artillery was developed, a strong conservative minority among the Army's senior leaders was able to prevent the total fielding of the new equipment. Likewise, the Army must remain sensitive to the apprehension of individuals as the technology is developed and implemented and it must develop

training programs to reduce technological apprehension amongst the force. Given that the equipment necessary for automation has not yet arrived, a similar situation could occur in the future.

The Army must also continue the acquisition reform program adopted in the 1990s if it intends to remain on the leading edge of technology. In both motorization and automation, inadequate and inefficient acquisition led to the failure of the Army to keep pace with similar applications of technology in the civilian sector. Equally important, the development of doctrine concurrent with equipment is fundamental to maximizing the capability of automated command and control systems once fielded throughout the force. Finally, in an era of shrinking defense budgets and increasing oversight from agencies outside of the Defense Department, the Army cannot afford to push another automated command and control system out to the field before it is unequivocally capable of performing as designed.

The Army of 1999 exists in a rapidly changing world, of which technological innovation is a major part. While it may appear that such change is unprecedented, this study's examination for the development of towed artillery proves that is not the case. Artillerymen of the 1920s and 30s faced the same sort of challenges in front of the Army today, namely how to examine, develop and implement new systems in order to gain a decisive edge on the modern battlefield. Application of the insights gained from the replacement of horses with tractors can significantly reduce the anxiety and trauma, both personal and organizational, associated with implementing automated command and control.

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ANNEX A GLOSSARY

Automated Command and Control--The concept of using an integrated system of computers and communications equipment to facilitate the exercise of command and control.

Battle Command--The art of battle decision making, leading, and motivating soldiers in their organizations into action to accomplish missions. It includes visualizing the current and future states, then formulating concepts of operations to get from one to another at the least cost. Battle Command also includes assigning missions, prioritizing and allocating resources, selecting the critical time and place to act, and knowing how and when to make adjustments during the fight. Battle command, therefore, is composed of two elements; the ability to decide and the ability to lead.⁷⁸

Command--The art of motivating and directing soldiers and organizations to accomplish a mission--must be supported by the means to regulate the forces to achieve the commander's intent.⁷⁹

Conservatism--The tendency to accept an existing fact, order, situation or phenomenon and to be cautious or suspicious of change: an extreme wariness and caution in outlook.⁸⁰

Control--Control is monitoring the status of organizational activities, identifying deviations from commander's intent, and regulating the forces and means toward an intended aim. Commanders acquire and apply means to accomplish their intent. Ultimately, commanders provide methods to measure, report, and correct performance.⁸¹

Digitization--Digitization is the near-real-time transfer of battlefield information between diverse fighting elements to permit a shared awareness of the tactical situation. It is also the leveraging information-age technologies to enhance the art of command and facilitate the science of control.⁸²

Mechanization-- The use of armed and armored vehicles in a military force, in particular the application of self propelled artillery, tanks and armored personnel carriers. Mechanization is a subset of motorization.

Motorization--The use of automotive equipment as a replacement for animal or human labor, either by towing or self-propulsion.

Technocrat—One who believes that the advent of science and technology makes a traditional system obsolete the traditional economic system obsolete.⁸³

ENDNOTES

¹ Boyd L. Dastrup, *King of Battle: A Branch History of the U.S. Army's Field Artillery*, TRADOC Branch History Series. (Fort Monroe, VA: Office of the Command Historian, United States Army Training and Doctrine Command, 1992), 180. The Hero Board concluded that the decreasing availability of trained horses, combined with the insufficient procurement of motor vehicles and spare parts made the urgent development of motorized artillery systems critical, and recommended further experimentation to determine what type of motor vehicle should replace the horse. The Lassiter Board, based on a series of motorization experiments, concluded that each division's artillery should be motorized by converting the 155mm regiment and one of the 75mm regiments immediately, and the other 75mm regiment as soon as vehicles were available.

² Dastrup, 182.

³ Frederick W. Spencer, "A Slow March to Military Effectiveness: The Motorization of the United States Field Artillery, 1917-1941", Master's Thesis, Ohio State University, 1994, 22-23.

⁴ Norman M. Cary, Jr., "The Use of the Motor Vehicle in the United States Army, 1899-1939", Ph.D. dissertation, University of Georgia, 1980, 129.

⁵ William I. Westervelt, et al. "Study of the Armament and Types of Artillery Materiel to be Assigned to a Field Army." *Field Artillery Journal* 9 (July-August 1919): 325.

⁶ Westervelt, 341. The Westervelt Board recommended that all guns and howitzers larger than four inches be motorized immediately, but that motorization of 75mm guns and 4" howitzers only be motorized only "when conditions warrant".

⁷ There was also a brief period of experimentation with a concept called "portee artillery", wherein the gun, caisson and its tractor were loaded on a truck and trailer combination and towed as far as the road network (would allow, then dismounted and towed into position by tractor. The French employed this concept successfully in World War I, and the results of tests conducted in Hawaii in 1927 showed some promise, but the concept was never fully developed in the United States, largely due to technological problems with the trucks used in test and its failure as an efficient means of transport. See Charles W. Hensey, "Portee Artillery in the Hawaii Division", *Field Artillery Journal* 17(May-June 1927): 248-54 and Townsend Heard, "The development and Tactical Employment of Portee Artillery", *Field Artillery Journal*, 19 (March-April 1929): 119-27.

⁸ Field Artillery Board. "Horses, Tractors, and Self Propelled Mounts." *Field Artillery Journal* 13 (November-December 1923): 487.

⁹ Field Artillery Board. 491.

¹⁰ Harry G. Bishop, *Field Artillery: King of Battles* (Boston: Houghton Mifflin Co, 1935).

¹¹ Field Artillery Board. 481-491. The board examined the text of a lecture by Lieutenant Colonel A.M. Chase delivered to the Army Center of Artillery Studies in Treves, France on March 8 1919, a copy of which was forwarded to the Chief of Ordinance on March 19 1919. Although no copies of this lecture are available, the FA Board report provides sufficient direct quotation to allow the reader to understand LTC Chase's position in favor of self propelled artillery and his supporting arguments.

¹² Field Artillery Board. 474.

¹³ Spencer, 35.

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- ¹⁴ Dastrup, 190.
- ¹⁵ FA Journal Article.
- ¹⁶ W.E Burr, "Some Aspects of American Field Artillery", *Field Artillery Journal* 12 (May-June 1922): 184.
- ¹⁷ Burr, 184.
- ¹⁸ Dastrup, 193.
- ¹⁹ Cary, 140.
- ²⁰ United States Army Field Artillery School, "Current Field Artillery Notes." *Field Artillery Journal* 19 (January-February 1929): 84.
- ²¹ Spencer, 43.
- ²² Fred T. Austin, "Annual Report of the Chief of Field Artillery." *Field Artillery Journal* 19 (January-February 1929): 22.
- ²³ Spencer, 42.
- ²⁴ Ibid.
- ²⁵ W.C. Dunkel, "The Truck Drawn Battery", *Field Artillery Journal* 22 (May-June 1932): 250.
- ²⁶ Harry G. Bishop, "Annual Report of the Chief of Field Artillery", *Field Artillery Journal*, 22 (Nov-Dec 1932): 590
- ²⁷ Dunkel, 245. Dunkel predicted that the population of horses in the United States would fall to less than 5 million by the end of 1942.
- ²⁸ Dastrup, 192. Ironically, the belated acceptance of towed artillery by the War Department and the greater Field Artillery community would place the development of self-propelled artillery at a virtual stand still. Virtually all artillerymen felt that towed artillery was superior to self-propelled in terms of maneuverability, maintenance and stealth on the battlefield. Even as late as 1939, Major General Robert Danford adamantly refused to support the introduction of self-propelled artillery, believing that towed artillery was clearly superior. See Dastrup, *King of Battle*, 192-193.
- ²⁹ Dastrup, 193.
- ³⁰ Robert M. Danford, "Horse and Motor for Artillery", *Cavalry Journal*, 58 (November-December 1939): 509.
- ³¹ Danford, 509.
- ³² Spencer, 99.
- ³³ Dastrup, 193.
- ³⁴ Russell F. Weigley, "Shaping the American Army of World War II: Mobility Versus Firepower", *Parameters*, 9, no. 3 (September 1981): 20. Weigley argues that the guns the Field Artillery used at it entered World War II lacked both the firepower and mobility required to support an Infantry division. See also Conrad H. Lanza, "Lessons From Spain", *Field Artillery Journal* 13, (Mar-Apr 1938):

195. In frustration, Lanza wrote "Modern weapons have changed war, and we cannot count upon the old systems of tactics being of value today. We have not had meeting engagements since our Civil War, and not many then. Seventy years after this type of warfare has disappeared, we are still teaching it. Advance and rear guards marching on roads in columns are now impossible. The British have boldly abandoned this idea, and practice advancing on a wide front, with small mobile motorized bodies. Some of our generals have practiced this maneuver, but we continue to instruct in old formations which are completely obsolete."

³⁵ Martin Van Creveld, *Command In War*, (Cambridge, MA, Harvard University Press, 1985): 264.

³⁶ William A. Owens, *Dominant Battlespace Knowledge*, ed. Stuart E. Johnson and Martin C. Lubiki (Washington D.C., National Defense University, 1996): 4.

³⁷ Leland A. Wilson and Kenneth S. Heitzke, "ARTADS: The Computer on Future Battlefields", *Army* 24, no. 6 (June 1974): 15.

³⁸ For an award winning discussion on the history of automated command and control systems in the U.S. Army see Elizabeth A. Stanley, "Evolutionary Technology In The Current Revolution In Military Affairs: The Army Tactical Command and Control System," individual research paper, Strategic Studies Institute, United States Army War College, 25 March 1985.

³⁹ Stanley, 13. FIELDATA was developed for use with the Mobile Digital Computer. The system showed promise in its early stages but following the Army's reorganization 1962 the program was cancelled due to the elimination of funding. Nonetheless, the Pentagon determined that the FIELDATA project had demonstrated sufficient potential to warrant further experimentation, and it directed the Army's Command and General Staff College to conduct further research as part of a comprehensive plan called "Command and Control Information Systems 1970" (CCIS-70). CCIS-70 divided the battlefield into five functional areas; maneuver, intelligence, fire support, air defense and combat service support and examined each as a candidate for automation. This battlefield division would remain a key component of future automated systems.

⁴⁰ Eric C. Ludvigsen, "Lifting the Fog of War," *Army* 22, no. 7 (July 1972): 31.

⁴¹ Stanley, 14. While an in depth discussion of ARTADS is beyond the scope of this paper, some aspects of the TOS and TACFIRE programs are worth noting. TOS, as the heart of the ARTADS system, was intended to standardize reporting and orders dissemination and provide the horizontal integration with other components of the system. Tests in both Europe and Fort Hood were unsuccessful, primarily because TOSs software for intelligence and maneuver functions never met the required standards. After spending \$100 million over seven years, Congress cancelled the TOS program. Likewise, TACFIRE had substantial problems in its development and fielding. The Army realized that development of the equipment had to reflect the needs of the end user, in this case the Field Artillery. In spite of implementing the concept of "spiral development", where contractors collected data on user requirements, incorporated them into interim prototypes, then continued to refine the development process, the Field Artillery was never satisfied with the final TACFIRE system, and a 1980 Government Accounting Office report recommended delaying full scale production until the numerous hardware and software deficiencies could be corrected. Even after full-scale production, TACFIRE was never popular among the majority of Field Artillerymen.

⁴² Stanley, 18. "Sigma", the classic mathematical symbol, represented integration while "Star" symbolized the five battlefield functional areas: maneuver, intelligence, fire support, air defense, and logistics.

⁴³ Stanley, 26.

⁴⁴ Jack Robertson, "Army Computers: Try, Try Again," *Chilton's Electronic News*, 37 no, 1875 (26 August 1991): 10.

⁴⁵ GAO Report.

⁴⁶ Stanley, 32.

⁴⁷ The term "stovepiped" referred to computer systems that were incapable of sharing information or passing data with other systems used by different functional areas. For example, the TACFIRE system was capable of storing intelligence on targets acquired by the fire support system, but it was incapable of sending the information to the division's intelligence sections.

⁴⁸ United States Army Combined Arms Center, *U.S. Army Combined Arms Center Annual Command History, 1992-93*, available at <http://call.army.mil/call/cachist/leav9293/chap5.htm>. Accessed 12 November 1999.

⁴⁹ Stanley, 36.

⁵⁰ Combined Arms Center.

⁵¹ United States General Accounting Office (GAO), *Battlefield Automation: Planned Production Decision for Army Control System is Premature*, (August 1992): 4.

⁵² GAO, 25. In the official response to the GAO report, the Defense Department argued that the GAO did not understand the concept of "evolutionary acquisition". DOD claimed that evolutionary acquisition would allow for the development of the system by increments, meeting varying degrees of user requirements, instead of the end user waiting until the final objective system had been designed and tested. Evolutionary acquisition would, according to DOD, allow for user feedback to work into the development process, in much the same way commercial users were developing software and equipment. DOD also claimed that the GAO report was misleading in that the initial commitment for the purchase of equipment was \$37 million rather than \$1.8 billion, with the remaining funds to be committed only after testing had proved the equipment sufficient to move into the acquisition stage.

⁵³ United States General Accounting Office, *"Battlefield Automation: Software Problems Hinder Development of the Army's Maneuver Control System"*. (Washington, D.C. October 1997): 3.

⁵⁴ GAO, *Software Problems Hinder Development of the Army's Maneuver Control System*, 18.

⁵⁵ Gordon R. Sullivan, *Army Digitization Campaign Plan*, (31 January 1995) available at <http://www.adc.army.mil/Br&doc/docs/CampPlan/campplan.htm>, accessed 12 November 1999.

⁵⁶ Ibid.

⁵⁷ George C. Wilson, "EXFOR Performance Comes Under Scrutiny" *The Army Times*, May 26 1997: 3.

⁵⁸ Sean D. Naylor, "Hartzog Disputes Claims of Poor Performance at NTC", *The Army Times*, June 9 1997: 3.

⁵⁹ Mackubin T. Owens, "Technology, the RMA, and Future War", *Strategic Review*, 26 no. 2 (Spring 1998): 63.

⁶⁰ David Alberts, "The Future of Command and Control with DBK", *Dominant Battlespace Knowledge*, Stuart E. Johnson and Martin C. Libiki, eds. (Washington DC: National Defense University Press, 1995): 80.

⁶¹ Arnold Beichman, "Revolution in the Warfare Trenches", *Washington Times*, 31 January 1996: 17.

⁶² James Hazlett, "Just in Time Warfare", *Dominant Battlespace Knowledge*: 119.

⁶³ John R. Brooks, "The Results of the TF AWE Are In—Things Are A-Changin'", *Military Intelligence* 23 no. 3 (July-September 1997): 8.

⁶⁴ Mackubin Owens, 69.

⁶⁵ Paul K. Van Riper and Frank G. Hoffman, cited in Mackubin Owens, 69.

⁶⁶ As of the Fall of 1998, the results of tests in this area remained inconclusive. Observers of the Division Advanced Warfighting experiment concluded that commanders and staffs were able to cope with the massive amounts of data generated by the ABCS. On the other hand, a report published by Mounted Maneuver Battlespace Lab stated that in some experiments, automation of the reporting process overloaded the staffs with information and that digitization of the tactical Operations Centers in itself did not guarantee results on the battlefield. Additional information is available in The U.S. Army Training and Doctrine Command, "Division XXI Advanced Warfighting Experiment Final Report" (Restricted Distribution) and Mounted Maneuver Battlespace Lab "Battle Command Reengineering Phase 2 Final Report" (unpublished).

⁶⁷ William A. Owens, *Dominant Battlespace Knowledge*, 7.

⁶⁸ For an excellent discussion on the potential pitfalls of automated command and control see Thomas P. M. Barnett, "The Seven Deadly Sins of Network-Centric Warfare", *U.S. Naval Institute Proceedings* 125 no. 1 (January 1999): 36-39.

⁶⁹ The studies examined were the Task Force XXI AWE (March 1997), the Division AWE (November 1997), the Battle Command Reengineering Experiment-Phase 1 (December 1997), Army Experiment 5 (May 1998), and the Battle Command Reengineering Experiment-Phase 2 (June 1998).

⁷⁰ Text of an interview between Colonel Rick Lynch, and John Johnston, 21 April 1999.

⁷¹ John E. Miller and Kurt C. Reitlinger, "Force XXI Battle Command", *Military Review* 75, no. 4 (July-August 1995): 9.

⁷² Huba Wass de Czege and Jacob Biever, "Optimizing Future Battle Command Technologies", *Military Review* 78, no. 2 (March-April 1998): 15.

⁷³ Albert F. Turner, "On the Path to the Digital Division: Force XXI and the AWEs", *Military Intelligence* 23, no. 3 (July-September 1997): 11.

⁷⁴ Jeffrey W. S. Leser, "Battle Command: Vision for Success", *Military Review* 77, no. 2 (March-April 1997): 52.

⁷⁵ Turner, 12.

⁷⁶ Less than sixty days from the start of World War II, General Danford retired from the Army "at his own request". Information regarding his retirement is incomplete. It is possible that he submitted his request to retire before the attack on Pearl Harbor, following the tradition set by his predecessors to retire following assignment as the Chief of Field Artillery. It is also possible that General Danford was one of the many officers asked to retire by Army Chief of Staff George Marshall as he set about to move younger, more open minded officers into senior level positions. Regardless, one thing is certain. General Danford's continued insistence that horse drawn artillery had a place on the modern battlefield in spite of glaring

evidence to the contrary must have had an impact on Marshall's decision to approve Danford's retirement even though the nation just entered the largest conflict yet known to mankind.

⁷⁷ Dastrup, 201.

⁷⁸ United States Army, United States Army Training and Doctrine Command Pamphlet 525-200-1: Battle Command Battle Dynamic Concept. Accessed 27 October 1999. Available at <http://www-tradoc.army.mil/tpubs/pams/p5252001.htm>.

⁷⁹ TRADOC Pam 525-200-1.

⁸⁰ *Webster's Third New International Dictionary*, G.C. Merriam Co., Springfield MA, 1971: 483.

⁸¹ Ibid.

⁸² United States Army, *Field Manual 101-5-1: Operational Terms and Graphics*, accessed 27 October 1999, available at <http://www-cgsc.army.mil/cdd/f545/f545con.htm#contents>.

⁸³ *The Encarta 99 Desk Encyclopedia*, Microsoft Corporation, 1998.